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Original Research

Sonography and computed tomography in aortic aneurysms: Radiological approach to a public health problem

Computed tomography and sonography in aortic aneurysms

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Abstract

Aim: Aortic aneurysms and their complications are among serious public health problems which are still subject of scientific researches. In this study, we aimed to present sonography (US) and contrast-enhanced computed tomography (CT) findings in patients who were referred to the radiology department with various complaints such as abdominal pain, severe chest pain, with the preliminary diagnosis of aortic aneurysm. We also aimed to determine the mean diameters of the aneurysms, and to demonstrate the type and frequency of their complications.

Material and Methods: Overall, 46 patients (30 males, 16 females) with a mean age of 67.6 years were included in the study. The locations and types of aneurysms, the types and frequency of their complications were determined, and the diameters of the aneurysms were obtained. Numerical values were given as mean values, percentages and n = n1/total number.

Results: In the present study, 2.1% (n = 1/46) of the patients had a saccular type aneurysm while 89.1% (n = 41/46) had the fusiform type aneurysms and 8.6% (n = 4/46) had aortic dissection. Of these patients, 52.1% (n = 24/46) had an abdominal aortic aneurysm (AAA), 36.9% (n = 17/46) had a thoracic aortic aneurysm (TAA), and 8.6% (n = 4/46) had aortic dissection.

Discussion: Sonography and CT scans should be the first-line methods for the diagnosis of aortic aneurysms and their complications, which are important public health problems.

Keywords

Aneurysm; Sonography; Tomography; Aorta

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Introduction

An aneurysm is generally defined as a 50% increase in the normal diameter of a blood vessel [1]. Abdominal aortic aneurysm (AAA) is defined as a focal enlargement >3 cm in the sonography literature [2]. For adults aged>50 years, the aortic diameter is 12-19 mm in women and 14-21 mm in men [3]. The AAA prevalence is 1.4% in the general population; 6% in individuals aged <80 years and 6-20% in those with atherosclerotic disease [4]. It is more prevalent among men than women (male to female ratio: 5-9: 1) [1-4]. The AAA is often seen in adults aged >60 years [5]. The AAA rupture is the thirteenth most common cause of death in the United States (US) [2]. A Thoracic aortic aneurysm (TAA) can be associated with hypertension, coronary artery disease, and AAA [6-8]. The TAA is the most common vascular cause of mediastinal mass lesions [5-8]. Direct radiography, aortography, ultrasound (US), multi-slices computed tomography (CT), and magnetic resonance (MR) imaging are used in the diagnosis of AAA and TAA [9, 10]. In an aortic aneurysm, an important public health issue, the localization, diameter and complications of the aneurysm affect mortality and morbidity. In this study, we aimed to present sonography and contrast-enhanced CT scan findings in cases with AAA, and contrast-enhanced CT scan findings in cases with TAA and to detect aneurysm diameters, and type and frequency of complications in the whole study population.

Material and Methods

This retrospective, cross-sectional study included 46 cases (30 men and 16 women, mean age: 67.6 years; age range: 34-86 years) who were referred from the emergency department for initial diagnosis of thoracic/abdominal aortic aneurysm/dissection with complaints including severe or chest pain associated with tearing sensation and/or hypotensive shock and/or findings such as pulsatile abdominal mass between 2015 and 2018. In addition, we excluded 21 cases referred with the above-mentioned complaints, findings and initial diagnoses, in which pathologies other than aortic aneurysm were detected on sonography and/or CT scan. AAA was diagnosed by sonography and CT scan in 8.6% (n=4/46), whereas by sonography alone in 6.5% (n=3/46) and only by CT scan in 36.9% of cases (n=17/46). The CT scan was used in the diagnosis of TAA in 39.1% of cases (n=18/46). The diagnosis of aortic dissection was made by CT scan. The sonography was performed using a 3.5-3.75 MHz convex probe. CT scans were performed with intravenous contrast material infusion. In addition to axial CT sections, multi-planar reformatted (MPR) CT images and 3-D angiographic images were reconstructed for diagnosis. The localization, types, complications and frequency of aneurysms were identified, and the mean aneurysm diameter was calculated. Numerical variables were presented as mean, percent and n=n1/total. All patients gave written informed consent before imaging studies. The study was conducted in accordance with the tenets of the Helsinki Declaration.

Results

There were saccular aneurysms in 2.1% (n=1/46) (Figure 1) and fusiform aneurysms in 89.1% (n=41/46), while aortic dissection was detected in 8.6% (n=4/46) of the patients.

Figure 1. Saccular aneurysm in thoracic aorta on a) axial section and b) sagittal reformatted image (arrows).

Among patients with aneurysm, there was AAA in 52.1% (n=24/46) and TAA in 36.9% (n=17/46). The mean aortic diameter was 62±14 mm in AAA and 81±1.0 in TAA. Suprarenal localization and bilateral acute renal artery occlusion were detected in 2 cases (4.3%) with aortic dissection; of AAAs, 30.4% (14/46) were suprarenal. Unilateral or bilateral iliac artery involvement was observed in 13.0% (6/46) of cases with AAA. There was ascending aorta involvement alone in 23.9% (n=11/46) and ascending plus descending aorta involvement in 13.0% (n=6/46) of the cases with TAA. Mural thrombus at varying degrees was detected in all cases with AAA. Retroperitoneal bleeding and intraperitoneal fluid due to extravasation/rupture were observed as a complication in 8.6% (4/46) of AAA cases. Aortocaval fistula was detected in 2.1% (n=1/46) and pleural fluid in 2.1% (1/46) (Figure 2) of patients.

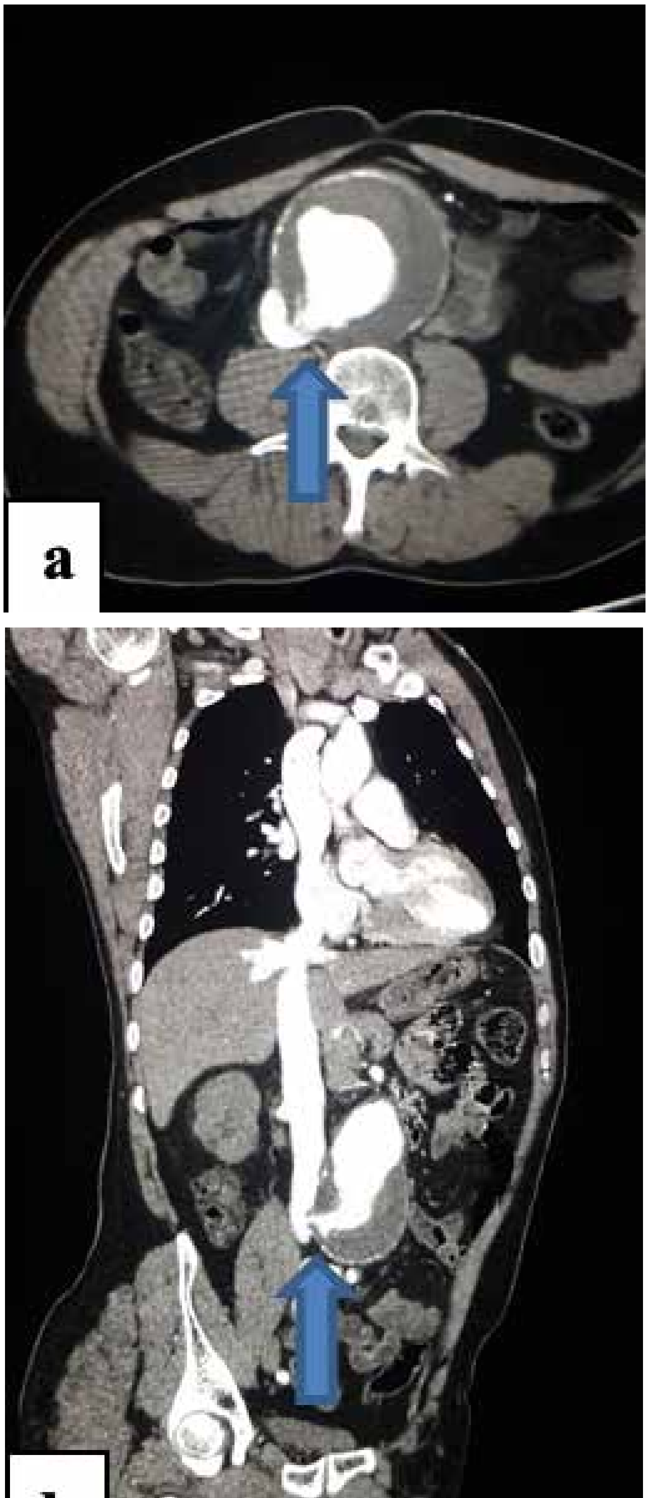

Figure 2. Spontaneous aortocaval fistula as a complication of an abdominal aortic aneurysm on a) axial section, b) coronal reformatted image (arrows).

Among the cases with aortic dissection, there was DeBakey type I aortic dissection (Stanford type A) in 25% (n=1/4) (Figure 3a), DeBakey type II aortic dissection (Stanford type A) in 50% (n=2/4) (Figure 3b) and DeBakey type III aortic dissection (Stanford type B) in 25% (n=1/4) (Figure 3c). Pericardial tamponade and bilateral pleural fluid were observed in one of the cases with (Stanford type A) DeBakey type II dissection, whereas right aortic arc in the other. In (Stanford type A) DeBakey type III dissection, it was seen that the left renal artery originated from the aortic lumen, while the right renal artery from the pseudo-lumen.

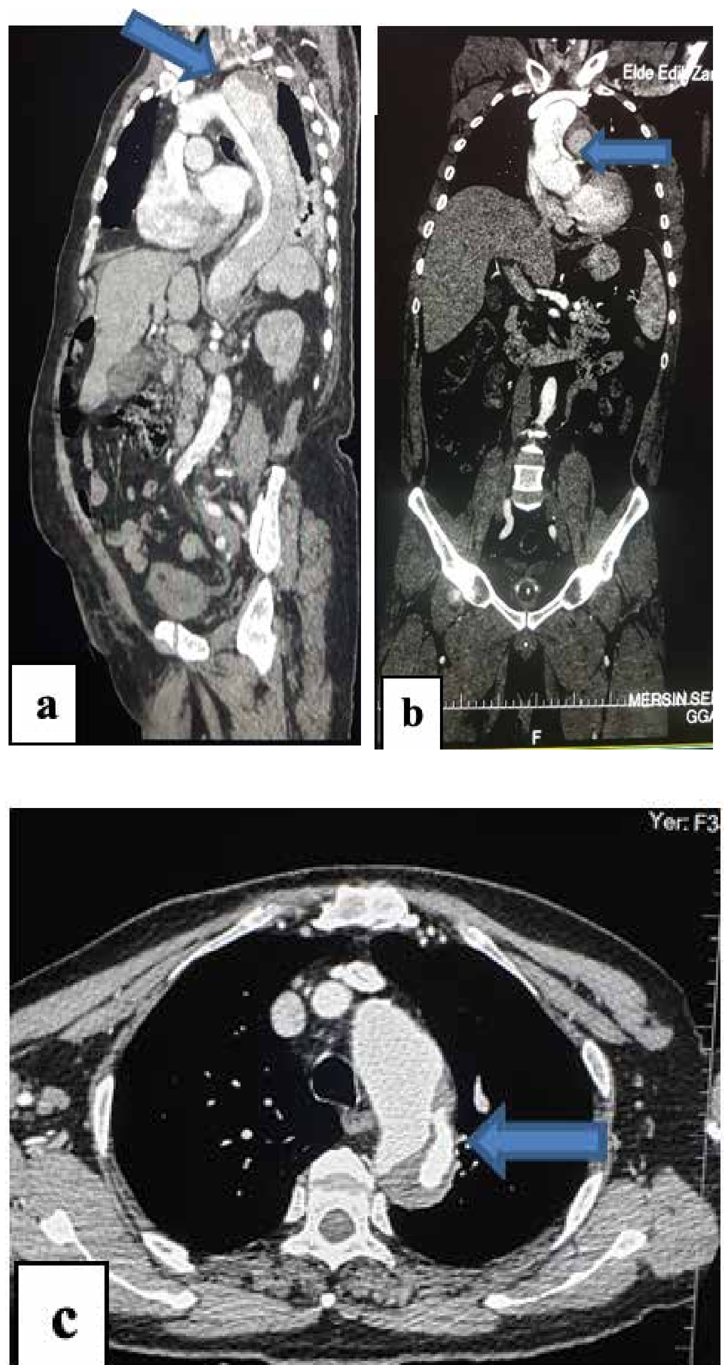

Figure 3. In the thoracic aorta: a) Stanford type A, DeBakey type I dissection on sagittal reformatted image; b) Stanford type A, DeBakey type II dissection on coronal reformatted image and c) Stanford type B, DeBakey type III dissection on axial section

Discussion

Atherosclerosis is the most common etiological factor in the development of aortic aneurysms (73-90%) [4]. In true aneurysms, permanent dilatation is observed, involving all layers with an intact vessel wall [3]. Fusiform aneurysm is the most common form (80%) where dilatation surrounds the aorta, while aneurismal dilatation is observed at one site of the aortic wall in the saccular aneurysm [1-3]. In this study, aneurysms were classified as fusiform in 97.6% and saccular in 2.3% of the cases.

The growth rate in aortic aneurysms with a diameter of 3-6 cm is 3.9 mm per year [2, 3]. Bincari et al. found that the mean growth rate in aneurysms with a diameter of 25-40 mm was 2.2 mm per year after 10 years of sonographic follow-up in 41 patients with small AAA [4].

The AAAs can be seen with visceral and renal artery aneurysms, isolated iliac and femoral artery aneurysms, Celiac trunk/superior mesenteric artery occlusion, renal artery stenosis, inferior mesenteric artery occlusion and lumbar artery occlusion at varying proportions [11]. Thus, radiological evaluations should clarify whether there is an involvement in the above-mentioned arteries, or whether involvement is infra-renal or suprarenal regarding aortic clamping; and left renal vein trajectory (whether retroaortic or not).

Infra-renal involvement is observed in 91-95% of AAAs, 66-70 of which extend to the iliac arteries [7-12]. In this study, 82.3% of AAAs were infra-renal, which is in agreement with the literature. However, it was found that the iliac artery extension rate (35.2%) was inconsistent with the literature. As a complication, retroperitoneal bleeding and intraperitoneal fluid due to extravasation/rupture were observed in 8.6% of cases with AAA. In addition, rare complications of aortocaval fistula and pleural rupture were successfully demonstrated by CT scan. In AAAs, the increased size of the areas limited by mural calcifications on direct radiographs can provide information about the size of the lesion. In eligible patients, the accuracy rate for measurement of aneurysm size using sonography is above 98% [6, 13]. Sonography is a choice of the imaging modality to monitor an increase in AAA size since it is an inexpensive, readily available and non-invasive tool. However, sonographic images are suboptimal in obese patients and those with excessive intra-abdominal gas. Sonography cannot show periaortic disease reliably; in addition, it is unable to detect proximal and distal extensions of the aneurysm in all patients. Thus, sonography cannot provide the information required for the preoperative assessment in patients undergoing elective aneurysm repair, although it may be helpful in acute settings [14]. Moreover, due to availability of multi-slices CT scan within seconds, contrast-enhanced CT scan, which can provide detailed information without data loss regarding all complications and extensions of aneurysms, has become the first choice without wasting time for sonography in emergency settings. However, sonography remains to be an imaging modality that can be applied rapidly, when needed, in centers having problems with the rapid use and interpretation of CT scans with appropriate specifications. In a study on cases with AAA, Vardulaki et al. reported that sonographic screening and periodical sonography assessment could decrease AAA-related mortality by 21% at 10-year follow-up [6]. The authors suggested that abdominal aortic diameter>60 mm, an increase by >10 mm per year in aneurysm diameter, and iliac artery aneurysm development (diameter≥30 mm) are sufficient for elective surgery, while abdominal aortic aneurysm diameter of 30-44 mm requires annual rescreening, and 45-59 mm requires rescreening at intervals of 3 months. Bianca et al. reported that the growth rate is low in small AAAs and that these aneurysms are occasionally life-threatening, emphasizing the importance of continuous sonographic monitoring [5]. In a case series of 101 AAA patients, Candio et al. performed sonographic screening before elective surgery and reported that there were slight differences between aneurysm diameter measured with sonography and those measured during surgery (0.5 cm on average); sonography accurately detected supra-, juxta- and infra-renal localizations; most iliac artery aneurysms could be demonstrated by sonography, suggesting that sonography is reliable for the preoperative assessment of AAA, and CT scan is indicated when juxta-renal or suprarenal aneurysms are suspected on sonography or when sonography is inconclusive. Based on sonographic data in our study, we think that sonography is not as helpful as suggested in the above-mentioned studies, and the finding that only 60% of cases with a retroaortic left renal vein can be detected with sonography alone reveals the need for preoperative contrast-enhanced CT. Since it is extremely important to demonstrate vascular variants such as retroaortic left renal vein or other abnormalities before AAA surgery in order to prevent bleeding during aortic surgery [8].

DSA, aortography, can be used in the diagnosis of AAA and TAA. However, the overall aneurysm diameter can be underestimated on aortography, since only the intact lumen can be observed on aortography. In addition, a false-negative result is possible if the pseudo-lumen is thrombosed or if the intimal flap is observed as non-phase [15-17]. Most aneurysms harbor thrombus. Aortography is an invasive, expensive modality requiring substantial amounts of contrast-material infusion [1, 18]. Currently, CT plus CTA provides the vast majority of the data that can be obtained with aortography, and additional data regarding surrounding tissues and complications due to its cross-sectional nature. Thus, aortography for aneurysm is rather performed in the context of therapeutic interventions such as endovascular stent-graft procedures today [9, 19].

MR imaging and MR angiography are used to diagnose aneurysms at all levels of the aorta with high sensitivity and specificity. Since contrast-enhanced CT scans provided all the data required for preoperative assessment and follow-up in our study, no MR imaging or MR angiography was performed in the emergency settings.

Hypertension is the most important risk factor for the onset of aortic dissection (60-90%) [3]. A dissection may accompany an aneurysm, or aorta with near-normal size can be observed in AAA and TAA. Aortic dissection develops within fusiform aneurysm in 28% of cases, and no dissection occurs in aneurysm with diameter <5 cm [1-3]. Major complications include aortic rupture, mesenteric ischemia or infarction, acute renal failure due to renal artery occlusion, and lower extremity ischemia in abdominal aortic dissection [19]. Anatomically, thoracic aortic dissection is classified using two classification systems, namely

DeBakey and Stanford. In the DeBakey system, dissection is classified into three types. Both the ascending and descending aorta are involved in DeBakey type I, while ascending aorta alone is involved in DeBakey type II, and descending aorta alone in DeBakey type III [9-14]. In the Stanford system, dissection is classified into two types. In Stanford type A, only the ascending aorta and only the first 4 cm of the aortic knob are involved. Seventy percent of dissections are of type A, which has a higher mortality due to the risk for tamponade, acute aortic failure, and dissection of coronary arteries or brachiocephalic arteries [9, 4]. The Stanford type B dissection begins from the distal to the origin or left subclavian artery and involves the descending aorta but not the ascending aorta [9, 14]. These have a more benign course as they do not involve aortic branches [9]. In our study, one of the cases with dissection was classified as DeBakey type I (Stanford type A), while two were classified as DeBakey type II (Stanford type A), and one case as DeBakey type III (Stanford type B). Pericardial tamponade and bilateral pleural fluid were detected in one case with DeBakey type II (Stanford type A) aortic dissection, while right aortic arc in another. In the patient with DeBakey type III (Stanford type A) dissection, it was shown that the left renal artery originated from the aortic lumen, while the right renal artery from the pseudo-lumen,

In our study, major limitation is the lack of long-term follow-up data. We could not monitor the annual growth rate. Another limitation is the small sample size. Although we thought that sonography should be performed following CT scans in all cases for comparison, it was not possible due to the clinical presentations of the cases and emergency settings. However, our data were beneficial regarding whether sonography or CT scan can be used preferentially, indicating the diagnostic importance and priority of CT scan.

Conclusions

Sonography and CT are choices of imaging modality in the diagnosis of aortic aneurysms and complications, which are important public health issues, particularly in the emergency settings.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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